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NINTH BIENNIAL REPORT

OF THE

COMMISSIONERS

OF THE

GEOLOGICAL AND NATURAL HISTORY SURVEY

Covering the Period from
July 1, 1912, to June 30, 1914

NORTH DAKOTA GEOLOGICAL SURVEY
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GEOLOGICAL AND NATURAL HISTORY SURVEY.

BOARD OF COMMISSIONERS.

FRANCIS E. McGOVERN,

Governor of the State.

CHARLES R. VAN HISE, *President.*

President of the University of Wisconsin.

CHARLES P. CARY, *Vice President.*

State Superintendent of Public Instruction.

JABE ALFORD,

President of the Commissioners of Fisheries.

DANA C. MUNRO, *Secretary.*

President of the Wisconsin Academy of Sciences, Arts and Letters.

STAFF OF THE SURVEY, 1914

ADMINISTRATION:

EDWARD A. BIRGE, Director and Superintendent. In immediate charge of Natural History Division.

WILLIAM O. HOTCHKISS, State Geologist. In immediate charge of Geology Division.

L. M. VEERHUSEN, Clerk.

GEOLOGY DIVISION:

WILLIAM O. HOTCHKISS. In charge.
T. C. CHAMBERLIN, Consulting Geologist, Pleistocene Geology.
SAMUEL WEIDMAN, Geologist, Areal Geology.
E. F. BEAN, Geologist, Chief of Field Parties.
W. L. UGLOW, Geologist, Assistant in Mine Valuation.
O. W. WHEELWRIGHT, Geologist, Chief of Field Parties.
R. H. WHITBECK, Geologist, Geography of Lower Fox Valley.
LAWRENCE MARTIN, Geologist, Physical Geography.
E. STEIDTMANN, Geologist, Limestones.
F. E. WILLIAMS, Geologist, Geography and History.
FRED GILLIS, Draftsman.

NATURAL HISTORY DIVISION:

EDWARD A. BIRGE. In charge.
CHANCEY JUDAY, Lake Survey.
H. A. SCHUETTE, Chemist.

DIVISION OF SOILS:

A. R. WHITSON. In charge.
W. J. GEIB, Inspector and Editor.
GUY CONREY, Chemist.
T. J. DUNNEWALD, Field Assistant and Analyst.
CARL THOMPSON, Field Assistant and Analyst.
ALBERT BUSER, Field Assistant and Analyst.
C. B. POST, Field Assistant and Analyst.

LETTER OF TRANSMITTAL.

Commissioners of the Wisconsin Geological and Natural History Survey, Madison.

Office of the President.

Honorable Francis E. McGovern,
Governor of the State.

Sir:—I have the honor to transmit herewith the report of Dr. E. A. Birge, Director and Superintendent of the Geological and Natural History Survey, for the biennial period extending from July 1, 1912, to June 30th, 1914.

During this period the Survey has carried on its investigations along the lines which have been followed in the past. The report of the Director shows the details of this work, which need not be discussed here, and for an account of them I refer to the detailed report transmitted herewith.

The legislature of 1913 placed in the hands of the rate commission the management of the water powers. This action, in whose wisdom the commissioners of the Survey heartily concur, makes it both unnecesary and inadvisable for the Survey to continue a water power division. We shall, however, be glad to cooperate so far as practicable with the rate commission in any survey of the water powers which they desire to make.

I desire to call especial attention to two important new duties assigned to the Survey by the legislature of 1913. The classification of the lands of the northern part of the state on the basis of their mineral value is of great importance in the development of this region. The work accomplished so far indicates that there are many areas in which exploration for iron ore should be carried on and the discovery and pointing out of these places will not only result in the saving of thousands of dollars of capital which would otherwise be expended uselessly, but will be of great service in placing the expenditure of capital in those areas most likely to yield returns. I would recommend that this work be continued until the whole northern portion of the state has been thus classified.

In the matter of mine assessment, grave inequity has resulted from the assessment of mining properties in the past by local assessors. In almost all cases these men are not equipped with sufficient mining experience to determine the values of such property, and as a consequence, mines have been both over-assessed and under-assessed. So long as the present system of taxation of mines is in vogue justice, both to the mining companies and to other property owners, makes it highly advisable that the valuation of mining properties be made by the Geological Survey.

The Soils Division has made rapid progress with the soil survey of the state. Many initial difficulties appeared incident to any such survey in its earlier stages. Among these were questons of the correlation of types of soil within the state and of these types with soils which had been classified outside the state. Such questions can be answered only after a considerable body of facts is in hand. This stage of the Survey is now passed and the work is progressing as fast as the funds devoted to it will permit. Both Professor Whitson and the Director are confident that the Survey will be finished within the time and the cost to the state which were originally estimated.

Very respectfully yours,
Charles R. Van Hise, President.

REPORT OF THE DIRECTOR OF THE SURVEY.

To the Commissioners of the Geological and Natural History Survey:

Gentlemen:— I submit herewith my ninth biennial report as Director and Superintendent of the Wisconsin Geological and Natural History Survey, extending from July 1, 1912, to June 30, 1914.

The income for the Survey has differed in the two years covered by this report. In the fiscal year 1912—13 the income was as follows:

General appropriation	$20,000

In the fiscal year ending 1913—14 the income was as follows:

General appropriation	$35,000
Special appropriation for Land Classification, Mine Valuation, Topography, Soils and Drainage	$28,000

In the year 1912—13 the printing for the Survey was done under the old printing law, according to which the printing was paid for from the general fund, and consequently no special appropriation was made for this purpose. The printing law passed by the legislature of 1913 altered this situation and made a specific allotment to each department to cover its printing. For this reason the general appropriation was increased from $20,000 to $35,000. The special appropriation—$28,000— was provided by the legislature for certain special work which it directed the Survey to undertake. The action of the finance committee suggested that of this appropriation $20,000 be spent in classifying the lands of the northern part of the state, $3,000 to be available for the purpose of making mine assessments, $2,000 for topography, $1,000 for drainage studies, and $2,000 for the soil survey in addition to the allotment made by this board to the soils division from the general appropriation of $35,000. This last was done so that $10,000 per year would be available for carrying on the soil survey.

The Bureau of Soils of the United States Department of Agriculture has coöperated in making the soil survey in the state and has expended approximately the same amount as the state in this work.

In addition to the above named amounts available for expenditure by this Survey, the sum of $600 was contributed annually by the U. S. Bureau of Fisheries toward the study of the lakes.

The United States Bureau of Fisheries has continued the assistance given in former years toward the study of lakes and the Wisconsin commissioners of fisheries have also aided in the work on the fishes of the state. The Survey extends its thanks to these organizations for the aid given.

In the last biennial report it was noted that the United States Bureau of Fisheries had enabled Mr. Juday and the director to spend some time in the study of lakes of central New York, thus enlarging and completing their studies on the Wisconsin lakes. The report on this investigation is now in type and it will soon be issued as a bulletin of the United States Bureau of Fisheries.

I. PERSONNEL OF THE SURVEY.

The names of persons employed permanently by the Survey and those who have given any considerable amount of time to the Survey are shown on the third page of this report. In addition to these persons many others have been employed for short periods as draftsmen, assistants in field parties, stenographic assistants, etc. It is not necessary to give the complete list of these person here, as the report of the Secretary of State contains the names of the persons employed, together with the amounts received by each. The kind of work in which each of the principal employees of the Survey was engaged is shown in a general way on the page where they are listed and the following report gives these lines of activity in more detail.

II. FINANCIAL STATEMENT.

In the following table I have summarized the expenditures of the Survey according to departments, thus indicating the main directions in which the money appropriated by the state has been expended. The result is as follows:

Secs. 172–24, 1 and 3, of the Statutes.

	1912–13	1913–14
Administration	$825.54	$1,439.05
Geology—		
State Geologist's Office	3,158.05	4,108.31
Areal Geology	2,708.34	2,939.11
Florence Iron District	571.07	
Limestones	1,485.17	87.50
Physiography	504.33	1,439.85
Mineral Land Classification		14,317.46
Mine Valuation		2,442.69
Lead & Zinc District		695.38
Lakes	2,642.15	4,439.43
Soils	8,428.84	10,644.18
Totals	$20,323.49	$42,552.96

In the year 1912—13 the printing was paid for by the state out of the general fund and is not included in the above statement for that year. This item amounted to $4,548.56.

Owing to the fact that the appropriations were not made by the legislature of 1913 until well into the summer, it was impossible to plan field work for the summer of 1913 to spend the appropriation for that year. It was also the wish of the Governor that the expenditures for the field season of 1913 be cut down as much as possible and that the work be concentrated in the field season of 1914, which would mean the fiscal year succeeding the two covered by this report. Consequently the expenditures during the fiscal year of 1913—14 were much lower than the appropriation made by the legislature and the expenditures in the year 1914—15 (field season of 1914) will be correspondingly higher.

III. WORK OF THE SURVEY.

The legislature of 1913 passed a water power act which gave the supervision of water powers into the hands of the railroad rate commission and very properly appropriated to this body the money necessary for investigations of stream flow. As a consequence of this the work on water powers which was started by this survey was no longer necessary. There was no further need for the water power division and it has therefore been dropped, as the highway division was dropped on the organization of the Highway Commission. The activities of the survey therefore come at present under the following three divisions:

1. Geology, in charge of State Geologist Hotchkiss.
2. Natural History, in charge of Director Birge.
3. Soils, in charge of Prof. A. R. Whitson.

A. GEOLOGY, IN CHARGE OF W. O. HOTCHKISS.

1. *Classification of Mineral Lands.* The legislature of 1913 directed the Survey to make a classification of the lands of the northern part of the state to show in so far as possible the lands having potential value for the discovery of iron ore, and made an appropriation to carry out this work. There has been in the last three or four years a large amount of interest in northern Wisconsin as to the possible location of iron ores. A large amount of private capital has been spent in exploration, some of it in situations where a careful scientific investigation would have shown there was no hope that ore might be found. Consequently it was the purpose to so classify the lands of the northern portion of the state that those persons who were interested in spending money to look for iron ore might know the best possible places to search for it. In this way only can the money of the citizens of the state, invested in the search for ore, be spent to the best possible advantage.

No detailed geological work has ever been done in the northern part of Wisconsin in the area under consideration. Such hasty investigations as had been made from time to time in the past indicated that there were very few outcrops, and that the rocks of the area as a whole were deeply covered by glacial drifts. Since such few outcrops as were observed were of granite, the whole area was shown on the old maps as probably being of this character. This fact discouraged the search for iron ore in Wisconsin for many years. In recent years, however, the search for iron ore has been carried on by more exact scientific methods than formerly, and it has been discovered that there are very favorable indications of the presence of iron ore in the northern part of the state.

The work under way has for its object a classification of the lands of the northern part of Wisconsin that will assist in developing an important natural resource. The facts of the situation lead naturally to a four-fold classification. A portion of the area is found to be underlain with granite and other igneous rocks, in which there is no possibility of the discovery of iron ore. These lands are "Class D." Due to the heavy glacial drift it is impossible to find out anything definite in regard to a large part of the area. This group of lands is classified as "unknown." It may eventually be shown to contain ore, or it may not, but present information gives little or no clue. These lands are "Class C". Other portions of the area are found to be underlain by Huronian rocks, the rocks which are associated with the iron ores of the whole Lake Superior District. This group of lands is set aside by itself as one having distinct possibilities for the finding of iron ore. These lands make up "Class B". Within these areas of Huronian rocks are other areas in which the presence of iron formations is definitely known, either through outcrops or through the evidence furnished by the magnetic survey. This last group of lands is set aside by itself as the most desirable to explore, and is "Class A".

In the two years of field work which were provided for by the legislature of 1913, about 90 townships will be covered. These townships are situated in Sawyer, Rusk, Washburn, Bayfield, Barron, Chippewa, Ashland, Price and Oneida Counties. The work is under the personal direction of Mr. Hotchkiss, and the field work is in charge of Mr. Bean and Mr. Wheelwright, who have charge of the parties in the field.

At the request of the Governor, only a small expense was incurred in this work in the field season of 1913 and most of the money appropriated for the biennium was expended in the field season of 1914.

2. *Mine Valuation.* The legislature of 1913 directed the survey to collect from the various mining companies of the state

such facts as might be necessary for the valuation of the mining properties. This work was undertaken in order to assist the Tax Commission and the local assessors in arriving at a true valuation of the mines. The determination of the value of a mine is at best a difficult matter. It involves a careful estimate of the amount of ore that can be taken out of the ground, and the profit which can be made in removing and selling this ore. It is obvious that for this purpose the services of persons experienced in the geology of ore deposits is most necessary, and the local assessors could not be expected to have this knowledge or to acquire it for the purpose of assessing mines. This work was undertaken personally by Mr. Hotchkiss with the assistance of Mr. Uglow in the valuation of the zinc mines. At the beginning of the work, a careful study was made of the various systems of mine taxation in vogue in other states or advocated in the literature by various students of the subject. As a result of this study it was found that the system in use by the Michigan Tax Commission in assessing the mines of that state had the fewest objections and accordingly it was adopted. Valuations have been made of all the mines in the state on this basis.

In arriving at the value of a mine, the object is to determine what a wise, conservative buyer would be willing to pay for the mine; what sum he could pay and assure himself of his ability to secure both the return of his capital and a reasonable rate of interest. Many facts have been collected from the various mining companies to show what profits they have made, what their mining costs have been, how much ore they have had in the mine and what their exploration records show they probably have ahead of them underground. In addition to the data furnished by the companies, Mr. Hotchkiss and Mr. Uglow personally went underground and examined practically all the mines. With very few exceptions the mining companies have welcomed this change in the methods of valuation and have assisted willingly by furnishing the data from which to arrive at a true valuation. They realized thoroughly the fact that the local assessors were not qualified by experience and training to form a correct idea of the value of a mine. As might have been expected, many very striking inequities in assessments were found. Mines were found assessed at a comparatively few thousand dollars, that were worth hundreds of thousands. Others were assessed at large sums, which careful investigation proved to have no value whatever or very moderate values.

The valuations of the various mines in the state have been completed and turned over to the Tax Commission as directed by law. In addition to this work the survey has had a representative attend several of the meetings of the boards of review, at the request of the Tax Commission, in order to assist the local boards of review in understanding the valuations placed upon the property. The valuations of the iron mines were made by Mr. Hotchkiss. Those of the zinc mines were made by Mr. W. L. Uglow, under the supervision of Mr. Hotchkiss.

In coöperation with some of the mine owners a careful study is now being made to discover some better method of taxing mines. The valuation as real property is attended with many difficulties which, if possible, should be avoided.

3. *Topographic Maps.* The last legislature appropriated money for the making of topographic maps in coöperation with the United States Geological Survey. Owing to the fact that the appropriation was made rather late in the year, it was impossible to complete arrangements in time to get any work started during the field season of 1913. This year Congress has delayed the making of appropriations for the various departments of the government, so that nothing as yet has been accomplished. However, a contract with the United States Geological Survey has been signed, under which three quadrangles will be surveyed. Those determined upon are the Superior Quadrangle, and two on the upper Fox River, covering Green Lake and part of the upper Fox River.

4. *Limestone Road Materials.* The investigation of the limestones of the state to determine their usefulness as road material was undertaken in 1912 by Mr. Steidtmann, under a coöperative arrangement between the State Highway Commission and the Survey. The bulletin is now in press and will be finished by the time this biennial Report is printed. The report has been prepared by Mr. Hotchkiss and Mr. Steidtmann jointly, and contains in brief form practical information for the use of road builders in the state. The bulletin is in two parts. The report is outlined as follows:

Part I. Introduction.
  General Characteristics of Wisconsin Road Materials.
    Distribution.
    Origin.
    Occurrence of Outcrops.
    Testing of Road Materials.
  Description of Tests.
    Hardness Test.
    Per Cent of Wear.
    Cementing Value.
    Specific Gravity and Weight per Cubic Foot.
    Absorption.
  Weight of a Cubic Yard of Crushed Stone.
  Qualities of Wisconsin Road Materials.
    Granite and Trap Rock.
    Sandstones and Quartzite.
    Shales.
    Gravel and Field Stone.
  Limestones.
    Lower Magnesian Limestone.
    Platteville or Trenton Limestone.
    Niagara Limestone.

Part II.
  County Descriptions. In this part each county containing limestones is described on the following general outline:
  A. General location of the various geological formations of the county, and reference to the plate showing them.
  B. The occurrence of outcrops of limestone.
  C. Descriptions of the various outcrops and their suitability for road material so far as known.
  D. Other material available in the county for road construction.
  E. Tests of local quarries or outcrops in that particular county.

5. *Limestones.* Based upon the material collected by Mr. Steidtmann for the preparation of the report on Limestone Road Materials, an investigation of the limestone of the state from a scientific point of view has been undertaken. This work has just been started and very little can be said about it except that scientific results of considerable interest and importance are being obtained even at this early stage of the investigation.

6. *Stratigraphy.* It has been known for some years that the

divisions and nomenclature of the Paleozoic rocks recognized heretofore in Wisconsin did not accurately express the facts. The economic importance of knowing the formations in greater detail has been strongly evident in the investigation of the limestones to determine their value as materials for road construction. Many very striking and important variations in what have heretofore been considered the same formations were noted in this work. For example, the highly variable character of the Lower Magnesian Limestone, for road purposes is largely due to the fact that there are two unconformable formations which have heretofore been considered as one. In some places one of these formations is present, and in some places another, and elsewhere both are present, so that irregularity is due not so much to change in the character of a single formation as to the fact that we are dealing with more than one.

The minor divisions of the lower Paleozoic strata are recognized outside of Wisconsin, but within the state nothing has been done on the stratigraphy of these rocks since the former geological survey of 1870—78. There are therefore many important and interesting scientific problems to be solved. While the work is purely scientific, and was not undertaken with the idea of accomplishing anything in the nature of economically important results, as in so many cases of purely scientific investigation the results are apparently to have an important economic bearing.

By coöperation with the United States Geological Survey, it has been possible to secure for this work the services of Dr. E. O. Ulrich, who is the best informed man on this continent with regard to the stratigraphy of these older formations. Mr. Ulrich and Mr. Hotchkiss visited the various important localities of the state during the present field season, and a report will be prepared by Mr. Ulrich during the coming year for publication by this Survey.

7. *Zinc District.* In the last biennial report mention was made of the investigation of the cost of mining in this district, undertaken at the request of various mine owners, so that authoritative information might be available for use in connection with the hearings before committees of Congress which were framing the tariff schedules on zinc ore. This investigation was completed and the information was used as intended. Later developments made it inadvisable to publish this, but to embody it in a report on the district as a whole, to be prepared within

the forthcoming year. This report is planned to be a monograph on the zinc district, covering the geology, methods of mining and milling the ore, together with data on the costs and other information of importance with regard to the district.

8. *Florence Iron District.* In the last biennial report, this investigation was described, and an outline given of the bulletin to be published upon it. It was believed at that time that the bulletin could be sent to press in a few months, but the many new duties assigned to the Survey by the last legislature have occupied the time of Mr. Hotchkiss so that it was impossible for him to complete the preparation of the manuscript up to the present time. After the close of the present field season, however, it is hoped that he will be able to devote sufficient time to it to get it ready for the press.

9. *General Services.* In its capacity of a general scientific bureau of the state, the Survey is called upon for many different kinds of service not directly related to its own work. The state geologist is ex-officio a member of the State Highway Commission and has given much time to the work of this body. Because of the fact that for a number of years this work was in his charge as part of the geological survey, he is very familiar with the work and consequently is called upon for many consultations. He was also requested to serve as chairman of a committee to investigate the land drainage situation for the Conservation Commission. This committee held a number of meetings and devoted much time to the study of drainage laws and in preparation of a report to the Conservation Commission on this subject. This report formed the basis for legislation enacted at the last session of the legislature. Governor McGovern appointed Mr. Hotchkiss as one of a committee of experts to investigate the general aspects of the Portage levee situation, to see if it were not possible to develop some system whereby the people benefited by these levees might be assessed for their construction and maintenance, rather than to throw the burden upon the state as a whole. This work has taken an additional amount of the time of Mr. Hotchkiss. These services have been given as part of the work of the Survey and as a duty to the public.

10. *Peat.* In the biennial report for 1909–1910 it was stated that a report on the peat resources of the state was nearly completed and an outline of the report was given. Owing to the

fact that Mr. F. W. Huels, the author, took up other employment in which it has been impossible for him to give time to the completion of the report, it has not been possible to send this to press, but it is believed that it can be finished and printed during the coming fiscal year.

This report will be of much value as the Survey is in frequent receipt of requests for information from persons interested in the development of peat in the state.

11. *The Soil Survey of Northwestern Wisconsin (South Part).* The soil survey of this area was completed by Dr. Weidman and assistants in 1910 and an edition of 8,000 copies issued in 1911. Owing to the large demand by farmers and prospective settlers interested in northern Wisconsin lands, this edition has already been exhausted and a second edition of 5,000 copies was issued during the present year, July, 1914. About half the expense of printing the second edition was borne by the State Board of Immigration, as this board is naturally the department to which many applications for such information are directed.

12. *Geology of the Northwestern Area.*—Dr. Weidman's report on the "Geology of the Northwestern Area," the geological work having been started at the same time as the survey of the soils of the area, is being completed as rapidly as possible. The report will cover the geology of the following nine counties: Eau Claire, Chippewa, Dunn, Pepin, Pierce, St. Croix, Polk, Barron, and Rusk, having a total area of about 6,800 square miles. Additional field work, however, is required in certain parts of the area and in adjacent territory in order to finish the work in a satisfactory manner. The part of the state adjacent to Minnesota presents many complicated geological features of much scientific importance, and these are being investigated with considerable care. The area contains rock formation ranging from the Pre-Cambrian to the youngest Pleistocene series.

The Pre-Cambrian is represented by the granites and greenstones of Chippewa and Rusk counties, and the Keweenawan trap and quartzite in Polk and Barron counties. The Paleozoic formations are represented by the Cambrian sandstones, the Lower Magnesian limestone, the St. Peter sandstone, and the Trenton limestone. The Pleistocene formations include the glacial and alluvial deposits and loess.

The correlations of the Paleozoic formations above mentioned, to be made by Dr. E. O. Ulrich, (described under paragraph 6 of this division) will serve as the basis for more accurate and detailed areal mapping of these formations. A revision of the old geological survey will thus be made possible and will be of great importance both for scientific and practical purposes.

13. *Report on Water Supplies.*—During the past few years Mr. Weidman has been occupied during the winter months mainly, with the preparation of a report on "The Underground and Surface Water Supplies of Wisconsin", the report being based on the manuscript report of A. R. Schultz of the United States Geological Survey which was submitted to the State Survey for publication in 1905. This report is now completed and is in the press. It consists of the following chapters:

Introduction.

Part I.
- Chapter I. Geology and Geography.
- Chapter II. General Conditions Controlling Movement of Underground Waters.
- Chapter III. The Flowing Artesian Wells of Wisconsin.
- Chapter IV. Prospecting for Artesian Wells.
- Chapter V. Springs and Mineral Waters.
- Chapter VI. The General Composition and Uses of Water Supplies.
- Chapter VII. The Chemical Quality of the Underground Waters.
- Chapter VIII. The Surface Water Supplies and Their Chemical Quality.

Part II. The description of water supplies by counties—presented under the following headings for each county:
- Surface Features.
- Geological Formations.
- Principal Water-bearing Horizons.
- Water Supplies for Cities and Villages.
- Quality of Water Supplies.
    - Table of Mineral Analyses.

The report contains about 600 pages and will be accompanied by a geological map of the state, showing artesian conditions, and the text will be illustrated with 60 figures of cross sections, small sketch maps, etc.

The report describes the numerous flowing wells of the state, the factors controlling their development, and offers suggestions concerning the prospecting for flowing wells. While there are certain parts of the state in which flows cannot be obtained, nevertheless there are various localities throughout certain sections favorably situated for developing flows which are well worthy of exploration. During the past year a hitherto undeveloped area east of Mondovi, in the Beef River valley, has produced many flowing wells, and there is good reason for anticipating the successful exploration of many other valleys of the state where conditions of geology and topography are favorable, as pointed out in this report.

Another special feature of the report is the discussion of the mineral quality of the water supplies with respect to their hardness, corrosive properties and their general industrial use. The discussion of the quality of the water is based upon the study of some 600 mineral analyses of underground waters and about 200 mineral analyses of river and lake waters, from all parts of the state. A small map of the state shows the various districts of the state in which soft, medium hard, hard, and very hard underground water is characteristic.

The data and description of local geological conditions, and the sources and character of water supplies presented in this work is for the purpose of furnishing to each county and locality the best information and deductions available concerning the water resources in various localities. For this purpose the general depth of the water-bearing strata in each county is given and illustrated by appropriate diagrams; the character and thickness of each water-bearing stratum is described; the artesian conditions are referred to; and the quality of the water in the various water-bearing formations is indicated. In addition more or less detailed descriptions of well sections and water supplies for each city or village are given as space appeared to warrant and the data permitted. It should be stated that a large amount of data bearing on the subject of water resources, which it appeared inadvisable to include, has been collected from various localities. This data has been studied and has been used as a basis upon which generalizations and deductions have been made concerning the underground local or county conditions.

The value of this published investigation will depend largely upon its intelligent use by local well drillers, municipal officers, engineers and others in search of water supplies. If any person desires additional information concerning the locality he is interested in, the State Survey will give him this information from its records so far as available.

14. *Statistics of Wisconsin Mineral Production.* For the two years covered by this report the State Survey has been cooperating with the United States Geological Survey in collecting statistics of Wisconsin mineral production. In this work a great mass of valuable information has been obtained at practically no expense to the state.

15. *Educational Bulletins.* The Bulletin on the "Geography and Industries of Wisconsin", which was in press at the time of issuing the last biennial report, was received from the printer and distributed. It has proved to be one of the most popular publications of the Survey. The demand from the schools was almost double the number it was possible to furnish, although an edition of 5,000 copies was printed. Many schools are using it as a textbook in teaching the geography of the state. The copies sent to the schools were not sent to students but to the school library so that they would be available year after year for successive classes.

The bulletin on the "Physical Geography of Wisconsin", by Professor Lawrence Martin, was outlined in the last biennial report. Owing to the pressure of other work he has not been able to get this ready for press but it is expected that a few months will see it ready for distribution. This also will doubtless be used as a textbook of physical geography in many schools and a great number of future citizens will be made better acquainted with the surface forms of the state and the reasons for these forms. The outline of the report by chapters is as follows:

- Chapter I. Brief Statement of Geology, Climate, Topography, Hydrography, and the place of Wisconsin in the Physical Geography of the United States.
- Chapter II. The Northern Highland.
    - Geological Provinces of the State.
    - The Northern Highland.
    - Effects of Glaciation.
- Chapter III. The Lake Superior Lowland.
    - General Description.
    - Glacial Modifications.
- Chapter IV. The Central Plain.
    - The Belted Plain.
    - The Central Plain.
    - Changes Due to Glaciation.
- Chapter V. The Eastern Ridges and Lowlands.
    - Location and General Geography.
    - Topography Controlled by Cuestas.
    - Magnesian Limestone Cuesta.
    - Green Bay–Winnebago Lowland.
    - Niagara Cuesta.

Chapter VI. Glaciation of Eastern Wisconsin.
  Topographic Features Due to Glaciation.
  Surface Feature due to Deposition.
Chapter VII. The Western Uplands.
  The Two Cuestas.
  The Upland of Magnesian Limestone and Potsdam Sandstone.
  The Baraboo Range.
  The Southwestern Upland of Galena–Trenton Limestone.
  Glaciation of Northwestern Section.
  The Driftless Area.
  Windwork During and Since Glacial Time.
  Work of Underground Water in Western Upland.
Chapter VIII. The Rivers and Lakes of Wisconsin.
  General Relationship of Rivers.
  The Wisconsin River.
  The Mississippi River.
  The Black, Chippewa and St. Croix Rivers.
  The Rock and Sugar Rivers.
  The Fox River System.
  The Menominee River.
  The St. Louis, Nemadji, Brule and Montreal Rivers.
  The Lakes of Northern and Northwestern Wisconsin.
  The Lakes of Eastern and Southeastern Wisconsin.
  The Swamps.
Chapter XI. Coasts of Wisconsin.
  General Relationships.
  Lake Michigan and Green Bay.
  Lake Superior.
Appendix. Suggestions as to Field Trips in Typical Areas of the State.

The report on "Geography and History of Wisconsin", which the last biennial report stated would be prepared by Mr. V. C. Finch, is now being written by Mr. F. E. Williams. Mr. Finch took up some work for the United States Department of Agriculture which made it impossible for him to spare the time and the report was turned over to Mr. Williams. It will probably be ready for distribution during the next fiscal year. This report will serve to inform the high school teachers, students, and others interested, as to the important part that geography has played in the history of the state. It will be valuable for use as a textbook in connection with the study of geography and history, and will be of interest to the general reader.

The report on the "Climate of Wisconsin" by Mr. Eric Miller, United States Weather Observer at Madison, has been partly completed. Owing to lack of time he finds it difficult to find opportunity to finish it for the press but plans to have it ready in the near future.

B. NATURAL HISTORY, IN CHARGE OF DIRECTOR BIRGE.

1. *Lakes.* The work on lakes has been, as heretofore, under the immediate control of the director, with Mr. Juday as permanent assistant in charge.

A full statement of the nature of the work now being carried on was made in the last biennial report and need not be repeated. The main objects of study are at present the quantity and composition of the plankton—the microscopic organisms of the open water which make up the fundamental food supply for all the animals of the lakes. This subject is proving, as was expected, very complex and only slow progress has been made. The difficulties which arise are partly mechanical and partly chemical, and, as the field of study is a new one, ways of overcoming them must be devised as they appear. Good progress has been made on both sides of the work but the study is still far from conclusion.

Numerous collections of the plankton have been made during the two years and routine chemical analyses have been completed. Chemical investigations have been also carried on, leading to more satisfactory methods of determining the chitin and the content of the alcohol extract.

Mr. Juday has completed the bulletin on the morphometry of the lakes of Wisconsin, referred to in the last biennial report. At the close of the present biennial period it was printed and ready for the bindery, and it was distributed in September, 1914.

One of the earliest tasks of the Survey in 1897 and 1898 was to make hydrographic surveys of lakes in Southeastern Wisconsin. Over fifty such lakes were surveyed and the results for most of them were published in the form of hydrographic maps. (See list at end of this Report.) The hydrographic data were also computed but have never been published. Mr. Juday has now brought together all of this information and much which has been gained later by this Survey, and also by others. It has been issued in a bulletin (No. XXVII) entitled "The Inland Lakes of Wisconsin—The Hydrography and Morphometry of the Lakes", by Chancey Juday.

This bulletin contains 152 pages, 6 topographic maps, 19 hydrographic maps, a map of the northeastern lake district, a map of the northwestern lake district, and 8 detail maps in the text. All of the hydrographic maps are on the metric system. The earlier edition of these maps was on the mile and foot system. The topographic maps are from the topographic sheets of the U. S. Geological Survey, and the maps of the northeastern and northwestern lake districts are from the general geological map of Wisconsin.

The bulletin contains tables giving full morphometric details of 53 lakes, four of which include eleven separate basins, The details of the hydrography are given only on the metric system but the more important general data are given both on this system and in miles, acres, and feet. Besides these detailed tables for the surveyed lakes there is given information regarding dimensions, area, and maximum depth of 44 additional lakes in Southeastern Wisconsin, 79 in Northeastern Wisconsin, and 63 in Northwestern Wisconsin. Thus the report gives information regarding 239 lakes. This number is only a small part of the lakes of Wisconsin and it will be seen that less than a quarter of the total number contained in the report have been fully surveyed. But even so the report contains a great amount of information never brought together before, and gives a detailed account of most of the larger and better known lakes of the state.

The report is divided into eleven chapters. The first gives a general account of the origin and extinction of lakes; then follow eight chapters discussing the several lake districts of Southeastern Wisconsin and containing the detail tables of hydrography. Chapter X gives an account of the lake districts of Northeastern and Northwestern Wisconsin, and chapter XI contains the general statistical tables and the maps and the formulae used in computation.

This bulletin is one of the scientific series. It is properly the first of a series of bulletins on the inland lakes of Wisconsin, although that on the dissolved gases* was the first to be issued. It will be followed by a third bulletin on lake temperatures, for which the data are already at hand, and a fourth will be based on the biological and chemical studies of the plankton now in progress.

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*Birge and Juday. Bulletin No. XXII. The Inland Lakes of Wisconsin. The Dissolved Gases of the Water and their Biological Significance. 1911.

A general account of the lakes of Southeastern Wisconsin has already been prepared by Professor N. M. Fenneman and issued by the Survey†. The hydrographic maps of most of the lakes were published shortly after they were surveyed. There is, therefore, already in print information regarding these lakes ample for the purposes of the general reader, and the present bulletin is almost wholly addressed to the interests of science. It has no illustrations except maps and its chief value lies in these and in the large compilation of hydrographic data. Brief accounts of the physiography of the lake districts are given, and those for the southeastern lakes are mainly taken from Fenneman's bulletin.

2. MINOR INVESTIGATIONS IN NATURAL HISTORY.

A. *Fish:* This work is in charge of Professor George Wagner. In the summer of 1912 the collection of fishes of the state was removed to the basement of the new biology building and was arranged systematically. It is now for the first time reasonably accessible. No regular work for the increase of the collection has been undertaken in the past two years. During the first year the work incident to the occupation of the new building consumed all of Professor Wagner's time and he was absent in Europe for study during the year 1913–14.

A number of interesting forms have been added to the collection. In connection with other work for the survey Dr. Pearse was able to add several species of the cisco of Lake Mendota, a form once common but of which we have found it difficult to secure specimens, although a number of attempts have formerly been made.

B. A survey of the hydrophytes or water plants growing in Lake Mendota was made in August and September, 1912, by Dr. R. H. Denniston.

Eighteen species of the higher plants were found growing in the waters of the lake from the shoreline to a depth of 20 feet. Tables and a map were prepared showing the areas covered by the different species, their abundance, and the depths at which they were found.

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†Fenneman, N. M. Bulletin No. VIII. Lakes of Southeastern Wisconsin. Second edition. 1910.

C. A bulletin on the Polyporaceae of Wisconsin has been prepared by Mr. J. J. Neuman. It is now in type and will soon be published. The polyporaceae are a group of fungi which include many saprophytic forms, and some which are parasitic and cause the decay of forest trees. Several of the species form conspicuous groups on the trunks of forest trees and are known as shelf or bracket fungi. These structures are the fruiting bodies of the fungi and in this group most of these structures are woody and in the form of brackets or crusts, while others are fleshy and mushroom-like in form. The author of the bulletin spent a season in the forests of northern Wisconsin in collecting material and studying the effect of the parasitic forms upon their hosts. Descriptions of these and other species collected by the author, and by other botanists in various parts of the state, are included in the bulletin.

The bulletin contains about 150 pages of text and is illustrated by 25 plates from photographs. It is being issued under the care of Dr. R. H. Denniston.

C. SOIL SURVEY, IN CHARGE OF PROFESSOR WHITSON.

The present Division of Soils was organized to undertake the preparation of soil maps and reports authorized by the Legislature of 1909, which appropriated $10,000.00 (ten thousand dollars) annually for two years for this work, to become available beginning July 1st, 1909. This division then planned to complete the reconnoissance survey of the northern part of the state, amounting to fifteen thousand square miles and to make a detailed survey of the older sections of the state by counties, covering an area of approximately twenty-five thousand square miles.

Arrangements were at once made with the Bureau of Soils of the United States Department of Agriculture to co-operate with the State in the survey of the detailed area and of the reconnoissance survey of the northeastern portion; the State to complete the reconnoissance survey of the northwestern portion unaided. In this cooperation the Bureau agreed to expend an equal amount of money with the State. Furthermore, the Bureau pays for the engraving of the maps so that the state is able to secure the desired number of maps for the State's edition of the reports by simply paying for the printing of the extra number required.

The following table shows the present status of the work being done by the Division of Soils.

PROGRESS OF SOIL SURVEY.

DETAILED SURVEY.

Name of area.	No. of square miles.	No. of soil types.	Field work conducted.	Condition of Report and Map.
Waushara County	643	14	1909	Published.
Bayfield Area	329	7	1909	Published.
Iowa County	763	13	1909, 1910	Published.
Waukesha County	560	20	1909, 1910	Published.
Fond du Lac County	720	17	1910, 1911	Published.
La Crosse County	475	18	1910, 1911	Published.
Juneau County	790	16	1910, 1911	Published.
Kewaunee County	340	21	1911	Published.
Columbia County	776	27	1911	Being prepared.
Jefferson County	576	27	1912	Being prepared.
Dane County	1,188	45	1912, 1913	Being prepared.
Buffalo County	662	17	1911, 1913	Being prepared.
Total (detail)	7,822			

RECONNOISSANCE SURVEY.

Reconnoissance of N. E. Wisconsin	6,020	29	1912, 1913	Being prepared.
including:				
Forest County.				
Florence County.				
Marinette County.		10	1909	
Oconto County.				
Shawano County.				
Langlade County.				
Reconnoissance of Forest Reserve Area	576 Completed.	10	Started in 1913: to be completed 1914.	To be issued Feb.. 1915.
including:				
Reconnoissance of North Part of North Central Wisconsin	3,834		Completed 1914.	Being prepared.
Vilas County,				
Oneida County.				
Iron County.				
Price County.				
Total reconnoissance under co-operative agreement	9,904			
Reconnoissance by state alone:				
North Part of N. W. Wis. Area.	6,323	14	1911, 1912	Published.
Total detail	7,822			
Total	24,049			

Mr. F. L. Musbach, assisted by Carl Thompson and T. J. Dunnewald, has completed the Reconnoissance Soil Survey of the North Part of Northwestern Wisconsin, including Douglas, Bayfield, Burnett, Washburn, Sawyer, and the western portion of Ashland Counties. His report has been published and covers a full description of the soils of that region, and includes a discussion of their agricultural management and value. This report will be of great service to those contemplating the purchase of land for development in that region.

In addition to the above areas the survey published in 1903 a report by Dr. Weidman on the soils of the North Central area of the state, including Portage, Wood, Clark, Marathon, Lincoln and Taylor counties, with the portions of adjoining counties. A third edition of this report is now in press. The area covered is about 7,200 square miles. Thus by the close of the field season of 1914 the field work for the reconnoissance survey of the northern part of the state will be completed covering safely 28,000 square miles. There also will have been published, or nearly completed, detailed surveys of 11 counties in the southern part of the state, covering nearly 8,000 square miles.

When the legislature of 1909 was asked to provide for an investigation of the soils of the state the survey estimated that the investigation could be completed in ten years with an expenditure by the state of $10,000 annually for field and office work. Since that time our understanding of the accuracy of the knowledge of soils needed for a proper survey has greatly increased, since in 1908 soil surveys were relatively new. In a similar way, it has been found necessary to make the survey in far greater detail than was originally planned. Nevertheless the survey has now advanced so far that we can say that with the aid of the United States Bureau of Soils the soil survey of the state can be completed within the estimated time and within the estimated cost to the state. The survey will be far better than was expected or than could be planned for in 1908, and this result is made possible by the cooperation of the United States government.

Dr. Weidman's investigation of the soils of the North Central area was made more than ten years ago. It has proved a most useful report but it does not represent the present state of our knowledge of the classification of soils and the field work could not be done with the detail of our present surveys. It is therefore planned to revise this report and it is hoped that the field work may be done during the season of 1915. If this can be accomplished the state will have a reconnoisance soil survey of this entire northern section, including all of that portion of the state in which the population is still relatively sparse. This survey will have been made rapidly and on uniform principle of classification.

IV. PUBLICATIONS.

During the biennial period there have been issued the following publications:

Bulletin No. XXV. Scientific Series No. 8.

Sandstones of the Wisconsin Coast of Lake Superior. Fredrik Turville Thwaites. Pp. viii, 117; 23 plates; large map in pocket; 10 figures in the text. 1912.

Bulletin XXVI. Educational Series No. 3.

The Geography & Industries of Wisconsin. R. H. Whitbeck. Pp. viii, 90; 23 plates; 46 figures in the text. 1913.

Bulletin No. XXVII. Scientific Series No. 9.

The Inland Lakes of Wisconsin. C. Juday. Pp. vi, 137; 29 plates; 8 figures in the text. 1914.

Bulletin No. XXVIII. Soil Series No. 2.

Soil survey of Waushara County. A. R. Whitson, W. J. Geib, Guy Conrey and A. K. Kuhlman of the Wis.Geol. Survey and J. W. Nelson of the United States Department of Agriculture. Pp. iv, 63; 3 plates, including one map. 1913.

Bulletin XXIX. Soil Series No. 3.

Soil Survey of Waukesha County. A. R. Whitson, W. J. Geib, and A. H. Meyer of the Wis. Geol. Survey and Percy O. Wood and Grove B. Jones of the United States Department of Agriculture. Pp. iv, 82; 3 plates, including one map.

Bulletin XXX. Soil Series No. 4.

Soil Survey of Iowa County. A. R. Whitson, W. J. Geib, T. J. Dunnewald and Emil Truog of the Wis. Geol. Survey and Clarence Lounsbury of the United States Department of Agriculture. Pp. 61; 2 plates, including one map. 1914.

Bulletin XXXI. Soil Series No. 5.

Soil Survey of the Bayfield Area. A. R. Whitson, W. J. Geib, L. R. Schoennmann and F. L. Musback of the Wis. Geol. Survey and Gustavus B. Maynadier of the United States Department of Agriculture. Pp. 51; 4 plates, including one map.
1914.

Geological and Road Map of Wisconsin.

54 inches wide and 62 inches long; on a scale of six miles to one inch.

The following publications are in press or ready to go to the printer:

"The Polyporaceae of Wisconsin", by J. J. Neuman; "The Limestone Road Materials of Wisconsin", by W. O. Hotchkiss and Edward Steidmann; "Physical Geography of Wisconsin", by Professor Lawrence Martin, "The Underground and Surface Water Supplies of Wisconsin", by S. Weidman, and "Methods of Mine Valuation and Assessment" by W. L. Uglow.

Other reports are also being prepared and will no doubt be finished and printed during the next fiscal year. They are as follows:

"Florence Iron District", by W. O. Hotchkiss.

"Peat", by F. W. Huels.

"Geology of the Northwestern Area", by S. Weidman.

"Geography and History of Wisconsin", by F. E. Williams.

"The Climate of Wisconsin", by Erie Miller, U. S. Weather Observer at Madison.

A report on "The Stratigraphy of Wisconsin" is also being prepared by Dr. E. O. Ulrich of the United States Geological Survey for publication by this Survey.

The following soil survey bulletins are in press: "Soil Survey of Kewaunee County", "Soil Survey of La Crosse County", "Soil Survey of Fond du Lac County", and "Soil Survey of Juneau County".

V. FUTURE WORK OF THE SURVEY.

A. LAND CLASSIFICATION, TOPOGRAPHY, MINE VALUATION, AND DRAINAGE.

The legislature of 1913 made a special appropriation of $28,000 per year for two years to the Survey and directed it to use the funds for classifying the mineral lands of the northern part of the state, for making topographic maps in co-operation with the United States Geological Survey, for making a valuation of the mines of the state, and for studying the effect of marsh drainage on stream floods. Two thousand dollars per year of this appropriation was directed to be expended, in addition to that allotted from the regular continuing appropriation of the Survey, for the carrying on of the soil survey of the state. This appropriation was allotted in accordance with the action of the joint finance committee.

For Land Classification	$20,000 per year
For Topographic Maps	2,000 per year
For Mine Valuation	3,000 per year
For Drainage Investigation	1,000 per year
For Soil Survey—additional	2,000 per year

While the making of appropriations for new subjects of investigation is not urged, it is believed most strongly that the work started under the special appropriation above mentioned should be continued.

1. The *Land Classification* work has shown results that promise to lead to the development of new iron ranges in northern Wisconsin and should be continued until all available information is secured for the use of citizens who wish to explore in any of the northern counties where iron may occur. The development of an important industry of this sort would be of great assistance in settling up the unoccupied lands of this section.

2. The *Topographic Mapping* should be continued as these maps will be of great use for a great variety of purposes. They are very much needed as a basis for the soil survey, for all geologic work, and are of great use in all engineering work such as land drainage, the building of steam and interurban railways, locating roads so as to avoid steep grades, for stream regulation and flood control, for study of the flow of streams, and for many

other purposes both private and public. The amount of money for this topographic mapping could be doubled with much profit to the state. This work should by all means be continued and on no smaller scale than at present. The United States Geological Survey coöperates with the Wisconsin Survey by putting in a dollar for each dollar available from the state.

3. The *Valuation of the Mines* by the Survey has been of much assistance both to the assessors and to mine owners in securing a fair, equitable assessment. Most mine owners would prefer to have this done by persons having special training rather than by the local assessors, and as this is the only way such property can be valued fairly this work should be continued.

4. The effect of *Marsh Drainage* on stream flow was to be investigated in connection with the stream gaging work. The stream gaging was later assigned to the rate commission by the Legislature and it was impossible for the engineer in charge to find time to take up this investigation of drainage for the Survey. As this investigation belongs with the work of stream gaging it should be turned over to the officers in charge of that work.

5. The *$2,000 per year additional for the soil survey work* should be continued and put on a continuing basis, as should also the appropriation for topographic mapping. These are both items of expenditure that should continue uninterrupted over a long period and the best interests of the state and maximum economy will be possible only if plans can be made for a number of years ahead. The uncertainty as to whether a succeeding legislature will appropriate the moderate sums necessary compels the work to be carried on under plans that cannot be made long in advance, with consequent disadvantages to the work. Appropriations made for these purposes are duplicated by the U. S. Government through the U. S. Geological Survey and the U. S. Bureau of Soils so that twice the amount of money made available by the legislature is expended on the work.

B. NATURAL HISTORY

The statement made in the Eighth Biennial Report in regard to the needs of this department might well be repeated here. The funds which are available are such as to permit the Survey to carry on one line of natural history study with reasonable facilities. This study has been and will continue to be devoted to the conditions of life in the lakes. These conditions are intricate and complex and little is known about them. Their study is correspondingly difficult and slow. With larger funds it would advance much more rapidly. Its present rate of progress has depended in part on assistance from the United States Bureau of Fisheries and on private aid. For the present, however, the available income is enough to secure a reasonable, though slow, progress, but as indicated in the last report, the investigation necessarily widens and grows more expensive as it advances. At present there should be added to the staff of this department a capable organic chemist, who could give nearly all of his time to the investigation of the chemical problems that are connected with the food supply of the lakes. The Survey is able at present to provide for routine analyses but it has not been able to give sufficient attention to the investigation of new problems and the discovery of new methods.

This Survey can accomplish little in natural history outside of this one line of investigation and there are many important matters associated with the life of the lakes which can not be touched. The full time of at least one assistant should be given to the study of fishes; a careful study of the food of fishes should be made and correlated with other studies on the lakes; the plants of the lakes, both the algae and higher plants need investigation; many great and important matters—important in both a theoretical and practical way—relating to the insect life in the waters of the lakes are untouched. In some cases a beginning has been made, chiefly by the aid of voluntary assistants, who work in summer for a sum about equal to their expenses, but no full study can be made in this way. The sum devoted to natural history could be wisely spent on lakes alone.

C. SOILS.

As indicated on an earlier page, the main necessity for the soil survey is the continuation of the present appropriations so that $10,000 can be given to the necessary field and office work of this division, and besides an adequate sum for publishing the reports as rapidly as they are prepared. The fact has already been noted that the United States Bureau of Soils contributes to this department a sum equal to that provided by the state.

PUBLICATIONS

OF THE

Wisconsin Geological and Natural History Survey.

The publications of the Survey are issued as (1) bulletins, which are numbered consecutively, (2) road pamphlets, (3) biennial reports, and (4) hydrographic maps. These publications are independently paged and indexed, no attempt being made to group them in volumes.

1. BULLETINS.

The bulletins are issued in three series:

Scientific Series.—The bulletins so designated consist of original contributions to the geology and natural history of the state, which are of scientific interest rather than of economic importance.

Economic Series.—This series includes those bulletins whose interest is chiefly practical and economic.

Educational Series.—The bulletins of this series are primarily designed for use by teachers and in the schools.

The following bulletins have been issued.

Bulletin No. I. Economic Series No. 1.

On the Forestry Conditions of Northern Wisconsin. Filibert Roth, Special Agent, United States Department of Agriculture. 1898. Pp. vi, 78; 1 map. *Out of print.*

Bulletin No. II. Scientific Series No. 1.

On the Instincts and Habits of the Solitary Wasps. George W. Peckham and Elizabeth G. Peckham. 1898. Pp. iv, 241; 14 plates, of which 2 are colored; 2 figures in the text. Sold at the price of $1.50 in paper and $2.00 bound.

Bulletin No. III. Scientific Series No. 2.

A Contribution to the Geology of the Pre-Cambrian Igneous Rocks of the Fox River Valley, Wisconsin. Samuel Weidman, Ph. D., Assistant Geologist, Wisconsin Geological and Natural History Survey. 1898. Pp. iv, 63; 10 plates; 12 figures in the text.

Sent on receipt of 10 cents.

Bulletin No. IV. Economic Series No. 2.

On the Building and Ornamental Stones of Wisconsin. Ernest Robertson Buckley, Ph. D., Assistant Geologist, Wisconsin Geological and Natural History Survey. 1898. Pp. xxvi, 544; 69 plates, of which 7 are colored, and 1 map; 4 figures in the text. Sent on receipt of 30c.

Bulletin No. V. Educational Series No. 1.

The Geography of the Region About Devil's Lake and the Dalles of the Wisconsin, with some notes on its surface geology. Rollin D. Salisbury, A. M., Professor of Geographic Geology, University of Chicago, and Wallace W. Atwood, B. S., Assistant in Geology, University of Chicago. 1900. Pp. x, 151; 38 plates; 47 figures in the text. *Out of print.*

Bulletin No. VI. Economic Series No. 3. Second Edition.

Preliminary Report on the Copper-Bearing Rocks of Douglas County, and parts of Washburn and Bayfield Counties, Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1901. Pp. vi, 83; 13 plates. Sent on receipt of 10c.

Bulletin No. VII. Economic Series No. 4.

The Clays and Clay Industries of Wisconsin. Part I. Ernest Robertson Buckley, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. 1901. Pp. xii, 304; 55 plates. Sent on receipt of 20c.

Bulletin No. VIII. Educational Series No. 2.

The Lakes of Southeastern Wisconsin. N. M. Fenneman, Ph. D., Professor of General and Geographic Geology, University of Wisconsin. 1902. Pp. xv, 178; 36 plates, 38 figures in the text. A second edition has been issued and will be sold at the price of 50c.

Bulletin No. IX. Economic Series No. 5.

Preliminary Report on the Lead and Zinc Deposits of Southwestern Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1903. Pp. viii, 103; 2 maps, 2 plates, 8 figures in the text. *Out of print.*

Bulletin No. X. Economic Series No. 6.

Highway Construction in Wisconsin. Ernest Robertson Buckley, Ph. D., State Geologist of Missouri, formerly Geologist, Wisconsin Geological and Natural History Survey. 1903. Pp. xvi, 339; 106 plates, including 26 maps of cities. Sent on receipt of 20 cents.

Bulletin No. XI. Economic Series No. 7. Second Edition.

Preliminary Report on the Soils and Agricultural Conditions of North Central Wisconsin. Samuel Weidman, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. 1903. Pp. viii, 67; 10 plates, including soil map. Second edition, 1908. *Out of print.* Map alone sent on receipt of 4 cents.

Bulletin No. XII. Scientific Series No. 3.

The Plankton of Lake Winnebago and Green Lake. C. Dwight Marsh, Ph. D., Professor of Biology, Ripon College. 1903. Pp. vi, 94; 22 plates. Sent, paper bound, on receipt of 10 cents.

Bulletin No. XIII. Economic Series No. 8.

The Baraboo Iron-bearing District of Wisconsin. Samuel Weidman, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. 1904. Pp. x, 190; 23 plates, including geological map. *Out of print.*

Bulletin No. XIV. Economic Series No. 9.

Report on Lead and Zinc Deposits of Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1906. Pp. ix, 100; 8 plates; 10 figures in the text; an atlas containing 18 maps. Sent on receipt of 25 cents.

A supplementary series of 6 maps including the Montfort, East Mineral Point, Ipswich, Big Patch, Elk Grove, Cuba City, and East Meeker's Grove sheets—by W. O. Hotchkiss and Edward Steidtmann—was issued in 1909. Sent on receipt of 6 cents.

In 1914 a series of 7 large scale blue prints were issued (scale 1 in. = 400 ft.). They were prepared in cooperation between the Geological Survey and the State Mining Trade School by R. E. Davis and W. O. Hotchkiss, and give in great detail data on lead crevices, mine workings, pitches, and underground crevices. They cover areas about Hazel Green, Benton, New Diggings, Platteville, Mifflin, the East End mine and the Coker mine. These maps are about 3 x 4 feet. They are sold at the cost of making the blue prints—at 25 cents per sheet.

Bulletin No. XV. Economic Series No. 10.

The Clays of Wisconsin and Their Uses. Heinrich Ries, Ph. D., Assistant Professor of Economic Geology, Cornell University. 1906. Pp. xii, 259; 30 plates, including 2 maps; 7 figures in text. Sent on receipt of 15 cents.

Bulletin No. XVI. Scientific Series No. 4.

The Geology of North Central Wisconsin. Samuel Weidman, Ph. D., Geologist, Wisconsin Geological and Natural History Survey. Pp. xxxi, 697; 86 plates, including 2 maps; 38 figures in the text. 1907. Sent on receipt of 20 cents.

Bulletin No. XVII. Scientific Series No. 5.

The Abandoned Shore-lines of Eastern Wisconsin. J. W. Goldthwait, Ph. D., Assistant Professor of Geology, Northwestern University. Pp. x, 134; 38 plates; 37 figures in the text. 1907. Sent on receipt of 10 cents.

Bulletin No. XVIII. Economic Series No. 11.

Rural Highways of Wisconsin. W. O. Hotchkiss, B. S., Instructor in Geology, University of Wisconsin; in charge of Economic Geology, Wisconsin Geological and Natural History Survey. 1906. Pp. xiv, 135; 16 plates; 2 figures in the text. Sent on receipt of 10 cents.

Bulletin No. XIX. Economic Series No. 12.

Zinc and Lead Deposits of the Upper Mississippi Valley. H. Foster Bain. Director of State Geological Survey of Illinois. Washington, D. C. 1907. Pp. xii, 155; 9 plates, including 5 maps; 45 figures in the text. Sent on receipt of 6 cents.

This bulletin is a reprint of Bulletin No. 294 of the United States Geological Survey. *Only a small number of copies were reprinted for local use. It has not been sent out to libraries and exchanges.*

Bulletin No. XX. Economic Series No. 13.

The Water Powers of Wisconsin. L. S. Smith, C. E.; Engineer Wisconsin Geological and Natural History Survey; Engineer U. S. Geological Survey. Pp. xvi, 354; 54 plates; 17 figures in the text. 1908. Sent on receipt of $2.00.

Profile maps of the Wisconsin river were issued by the United States Geological Survey, based on coöperative work with the Wisconsin Survey. The stock of these maps is now deposited with this Survey and the maps will be sent on the same terms as they were by the U. S. Survey, viz.: 5 cents per sheet, postpaid. There are eleven maps in this series.

Bulletin No. XXI. Scientific Series No. 6.

The Fossils and Stratigraphy of the Middle Devonic of Wisconsin. Herdman F. Cleland. Professor of Geology, Williams College. Pp. 206; 55 plates. 1911. Sent on receipt of 25 cents.

Bulletin No. XXII. Scientific Series No. 7.

The Inland Lakes of Wisconsin; the Dissolved Gases of the Water and their Biological Significance. Edward A. Birge and Chauncey Juday. Pp. xxi, 254; 10 plates, 142 figures in text; all diagrams of gases and plankton. 1911. Sent on receipt of 25 cents.

Bulletin No. XXIII. Economic Series No. 14.

Reconnoissance Soil Survey of Northwestern Wisconsin. S. Weidman, with the assistance of E. B. Hall and F. L. Musback. Pp. viii, 103; 15 plates, including one map; 16 figures in the text. 1911. Sent, paper bound, on receipt of 10 cents.

Bulletin No. XXIV. Economic Series No. 15.

Reconnoissance Soil Survey of Marinette County. Samuel Weidman and Percy O. Wood. Pp. 44, 4 plates, one map. 1911. *Out of print.*

Bulletin No. XXV. Scientific Series No. 8.

Sandstones of the Wisconsin Coast of Lake Superior. Fredrik Turville Thwaites. Pp. viii, 117; 23 plates; large map in pocket; 10 figures in text. 1912. Cloth Bound. Sent on receipt of 10 cents.

Bulletin No. XXVI. Educational Series No. 3.

The Geography and Industries of Wisconsin. R. H. Whitbeck. Pp. viii, 65; 23 plates; 46 figures in the text. 1913. Cloth bound. Sent on receipt of 10 cents.

Bulletin No. XXVII. Scientific Series No. 9.

The Inland Lakes of Wisconsin. C. Juday. Pp. vi, 137; 29 maps; 8 figures in the text. 1914. Cloth bound. Sent on receipt of 10 cents.

Bulletin No. XXVIII. Soil Series No. 2.

Soil Survey of Waushara County. A. R. Whitson, W. J. Geib, Guy Conrey and A. K. Kuhlman of the Wis. Geol. Survey and J. W. Nelson of the United States Department of Agriculture. Pp. iv, 63; 3 plates, including one map. 1913. Sent, paper bound, on receipt of 5 cents.

Bulletin No. XXIX. Soil Series No. 3.

Soil Survey of Waukesha County. A. R. Whitson, W. J. Geib and A. H. Meyer of the Wis. Geol. Survey and Percy O. Wood and Grove B. Jones of the United States Department of Agriculture. Pp. iv, 82; 3 plates, including one map. 1914. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXX. Soil Series No. 4.

Soil Survey of Iowa County. A. R. Whitson, W. J. Geib, T. J. Dunnewald and Emil Truog of the Wis. Geol. Survey and Clarence Lounsbury of the United States Department of Agriculture. Pp. 61; 2 plates, including one map. 1914. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXXI. Soil Series No. 5.

Soil Survey of the Bayfield Area. A. R. Whitson, W. J. Geib, L. R. Schoennmann and F. L. Musback of the Wis. Geol. Survey and Gustavus B. Maynadier of the United States Department of Agriculture. Pp. 51, 4 plates, including one map. 1914. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXXII. Soil Series No. 6.

Reconnoissance Soil Survey of North Part of Northwest Wisconsin. F. L. Musback, T. J. Dunnewald, Carl Thompson and O. I. Berg of the Wis. Geol. Survey. *In Press.* 1914. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXXIII. Scientific Series No. 10.

The Polyporaceae of Wisconsin. J. J. Neuman. Pp. iii, 156; 25 plates. *In press.* 1914. Cloth bound. Sent on receipt of 15 cents.

Bulletin No. XXXIV. Economic Series No. 16.

The Limestone Road Materials of Wisconsin. W. O. Hotchkiss and Edward Steidtmann. Pp. vii, 137; 2 text figures, 41 plates and geologic maps of counties. *In press.* 1914. Cloth bound. Sent on receipt of 10 cents.

Bulletin No. XXXV. Economic Series No. 17.

The Underground and Surface Water Supplies of Wisconsin. Samuel Weidman. Pp. xv, 650; 58 figures in text, 3 plates; and a colored geologic map of the state. Scale: 1 inch = 16 miles. *In press.* 1914. Cloth bound. Sent on receipt of 20 cents.

Bulletin XXXVI. Educational Series No. 4.

The Physiography of Wisconsin. Lawrence Martin. Associate Professor of Physiography and Geography. University of Wisconsin. About 20 pages. Numerous text figures and plates. *In press 1915.* Cloth bound. Sent on receipt of 15 cents.

Bulletin XXXVII. Soil Series No. 7.

Soil Survey of Fond du Lac County. A. R. Whitson, W. J. Geib, L. R. Schoennmann and C. A. LeClair of the Wis. Geol. Survey; and Guy Conrey and A. E. Taylor of the United States Department of Agriculture. *In press.* 1914. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXXVIII. Soil Series No. 8.

Soil Survey of Juneau County. A. R. Whitson, W. J. Geib, L. R. Schoennmann, and C. A. LeClair of the Wis. Geol. Survey; and E. B. Watson of the United States Department of Agriculture. *In press.* 1914. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents.

Bulletin No. XXXIX. Soil Series No. 9.

Soil Survey of Kewaunee County. A. R. Whitson, W. J. Geib, and E. J. Graul of the Wis. Geol. Survey; and A. H. Meyer of the United States Department of Agriculture. *In press.* 1914. Includes soil map of the county. Sent on receipt of 5 cents.

Bulletin No. XL. Soil Series No. 10.

Soil Survey of La Crosse County. A. R. Whitson, W. J. Geib, and T. J. Dunnewald of the Wis. Geol. Survey; and Clarence Launsbury of the United States Department of Agriculture. *In press.* 1914. Includes soil map of the county. Sent on receipt of 5 cents.

Bulletin No. XLI. Economic Series No. 18.

A Study of the Methods of Mine Assessments and Valuation. W. L. Uglow. Pp. iv, 106; 12 plates. *In press.* 1914. Cloth bound. Sent on receipt of 10 cents.

Bulletin No. XLII. Educational Series No. 5.

Geography of the Lower Fox Valley. R. H. Whitbeck, Associate Professor of Geography, University of Wisconsin. With numerous text *figures and plates. In press. 1915* Cloth bound. Sent on receipt of 10 cents.

ROAD PAMPHLETS.

In 1909 the Survey issued four Road Pamphlets. On the organization of the Highway Commission the stock of these pamphlets still in the hands of the Survey was turned over to that body. Any applications for these pamphlets should be made to the State Highway Commission, Madison.

2. BIENNIAL REPORTS.

The Survey has published nine biennial reports, which relate to administrative affairs only and contain no scientific matter.

First Biennial Report of the Commissioners of the Geological and Natural History Survey. 1899. Pp. 31.

Second Biennial Report of the Commissioners of the Geological and Natural History Survey. 1901. Pp. 44.

Third Biennial Report of the Commissioners of the Geological and Natural History Survey. 1903. Pp. 35.

Fourth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1904. Pp. 42.

Fifth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1907. Pp. 45.

Sixth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1909. Pp. 45.

Seventh Biennial Report of the Commissioners of the Geological and Natural History Survey. 1911. Pp. 55.

Eighth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1912. Pp. 38.

Ninth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1914. Pp. 40.

4. HYDROGRAPHIC MAPS.

There have been prepared hydrographic maps of the principal lakes of southern and eastern Wisconsin. This work was in charge of L. S. Smith, C. E., Associate Professor of Topographic and Geodetic Engineering, University of Wisconsin.

The maps are as follows:

		Size of Plate, Inches.	Scale. Inches per mile.	Contour. Interval, feet.
No. 1.	Lake Geneva	17.5x10.8	2	10
No. 2.	Elkhart Lake	15.5x13.1	5	10
No. 3.	Lake Beulah	22.5x20.0	6	10
No. 4.	Oconomowoc-Waukesha Lakes	29.8x19.1	2	10
No. 5.	The Chain of Lakes, Waupaca	21.7x20.6	6	10
No. 6.	Delavan and Lauderdale Lakes	22.5x16.8	4	10
No. 7.	Green Lake	26.0x17.8	3.2	20
No. 8.	Lake Mendota	23.7x19.5	6	5
No. 9.	Big Cedar Lake	18.0x13.5	2.9	10
No. 10.	Lake Monona	17.6x17.3	4	5

In all of these maps the depth of the lakes is indicated by contour lines, and by tints in all except No. 1. They are sent on receipt of 10 cents each and may be had either mounted in a manilla cover, or unmounted.

GEOLOGICAL MODEL OF WISCONSIN.

The Survey has prepared a model which shows in great detail the topography of the state. It is designed for use in schools, libraries, and similar public institutions, and is 49 inches by 45 inches in size. It is supplied to such institutions in Wisconsin at the cost of labor and materials used in its construction. The form showing topography alone is furnished for $31 and the form showing geology in addition to topography is furnished for $46. A special circular with illustration of the model may be had on application.

GEOLOGY AND ROAD MAP OF WISCONSIN.

A geological map of the state has been prepared and is now on sale. This is a large wall map 54 inches wide and 62 inches long. It shows all the roads of the state and the geology. The main travelled roads between cities are prominently shown by a red color. All counties, cities, villages, towns, Indian Reservations, railroad lines, rivers and lakes are shown. In the corners of the map are the legend, which gives the name, character and thickness and economic products of the various geologic formations; an outline of the geologic history of the state; and a table of elevations of the prominent physiographic features of the state. At the bottom are three sections showing the geologic structure. Under authority of the legislature this map is distributed to all the schools of the state by the state superintendent of Public Instruction. The map is sold to other persons by the state at the cost of printing, and can only be obtained from the Superintendent of Public Property. With substantial cloth mounting and roller and stick at bottom and top, the price is $1.00. The folded paper map suitable for sectional mounting is sold for 30 cents.

All correspondence relating to the Survey should be addressed to

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